DEVICE FOR TRAVERSING A FLEXIBLE LINEAR PRODUCT FOR SPOOLING RELATED APPLICATON

This application is a continuation-in-part of my co pending application; Serial No.09/342,826

5   filed April 27, 2001, which is a continuation in part of application Serial No.09/427,443 filed October 27,

1999, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates generally to the field of spooling a delicate flexible linear product such as

thread, wire, cable, hose, and the like. It also relates an improved guiding means, which moves in a plane

10   parallel to that of the spool/coil, which forms progressive layers of product as the spool/coil rotates, while

minimizing the stresses and tension fluctuations that are created by product misalignment and radial

bends.

The invention also relates to the process by which the traversing guide is synchronized with the

winding member to form the desired level wind package.

15   These objectives are accomplished by employing a pivotally mounted guide with the capabilities

of digitally addressing the desired position of the guide by calculating the rotational value of the winding

member and commanding the traversing guide to the precise location to form the layering desired without

the use of high wear cams or slide blocks.

DESCRIPTION OF THE PRIOR ART

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Traverse guiding means are well known in the art, and have included a pivotally mounted guide

having an orificed free end through which the product passes, as well as mechanical driving means,

including a driven crank and linkage communicating with a point on the guide.

Previous pendulum type devices have been employed to move a flexible product in a linear

25   motion while the product is being wound onto a package, such as a spool or coil. Some of these

mechanisms have not been concerned with linear motion synchronized with the rotation of the winding

members. Others include a mechanical cam device to compensate for the inconsistent motion of the

guide. These mechanical linkages add considerable inertia to the device, thereby slowing the spooling

process. In addition, these compensating components are of high frictional wear that reduces the life of said components. Previous devices have not performed direction reversal of the pivotally mounted guide, other than end of stroke mechanical linkage adjustments. Where the guide is driven at high speeds, the heavy inertial load of the mechanisms impedes any instant reversal of the path of movement. Previous

5   means of reversal have included mechanical cams, slides, complicated mechanical linkages, and gears of both arcuate and oval configuration. Previous traversing components, for the most part, have not addressed the tension fluctuations and product abuse that are common to traversing.

U.S. Pat. No. 4,015,798: Discloses a guide arm that moves in a radial arc from a common axis. The lateral traverse motion is provided by the rotation of a "double diamond lead screw"(barrel cam). The

10   cable is fed essentially coaxial with respect to the guiding arm and sheaves are provided to guide the product to the winding drum.

U.S. Pat No. 2,848,173: Relates to an apparatus for traversing a yarn to a specific profile that is accomplished by driving a pivotal guide through a complex gear/cam assembly.

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U.S. Pat No. 5,678,778: Relates to a reciprocating slide block guide that is driven by a cam box that compensates for the non-uniform motion due to angular losses.

In order to understand how the present invention differs from prior art, the criteria for the ideal traversing mechanism must be explored. When traversing a delicate filament at high speed, it is desirable

20   to guide the filament only in a lateral plane. Any deviation or bending of the filament from its relaxed alignment is detrimental. The tension, while winding, should be as consistent as feasible. The mechanism should possess the capability to change direction instantly with no lag in its synchronization to its defined path. The device should be capable of varying the full stroke, at will, thereby altering the width of the layer. The device should allow for pitch (lead) variation at will. The motion of the apparatus must be

25   dependable and not alter due to wear. Any angular disparities that are created by linkages should be compensated for without high wear, high inertia cams.

U.S. Pat. No. 4,015,798: This apparatus varies from the present invention in that it is not an axial

driven device. The driving member is a double diamond lead screw, which has no capabilities to change

pitch (lay) or stroke. The driving source of the cam is mechanically linked to the winding member and

5   incorporates no capabilities for ratio change or reversal, other than drive train modifications. Although

the invention may seem to feed the flexible product coaxial with respect to the to the pivot axis it shows

that the product is being rotated above the axis. This may seem to be a minor variation, but in high speed

traversing, the tension fluctuations produced by this deviant path are detrimental. The primary reason for

the feeding of the product coaxial with respect to the axis is to reduce tension fluctuations that are

10   common to linear traversing devices at high speed. By moving the feed closer to the axis as the disclosed

device teaches, these fluctuations are reduced, but they are still present. An additional difficulty with the

disclosed device is the multiple radial bends that are employed to route the cable to its final destination. In

winding a delicate flexible product at high speed, it is desirable to minimize any radial bends or distortion

to the elements natural path, that is, to endeavor to maintain as straight a path as possible. The second turn

15   around sheave guiding the element to the winding member introduces an additional radial bend to the

element. Thus this device was clearly not designed for high-speed delicate winding, as can be easily seen

by the mass of the structure.

U.S. Pat No. 2,848,173: The traversing motion of this apparatus is one of profiled traverse (non

20   linear). The motion of the traverse guide in this mechanism is totally dependant on the cam, gearbox and

linkages to form the desired layering and to compensate for the motion loss/gain of the angular

differences of the linkages. This traversing mechanism winds a predetermined path and lacks the

capabilities to change lay or traverse width other than mechanical retooling.

25   U.S. Pat No. 5,678,778: This apparatus employs a known master/follower scheme in the

regulation of the traverse guide. The follower circuitry of the traverse position controller differs

significantly from the present invention by the means by which the synchronization of the traverse guide

with the winding arbor is attained. The device is primarily a velocity follower (speed), which follows the

winding member (master). The reporting of the speed and location of the guide is reliant on a feedback

device that is positioned before the driving linkage. Any change or wear in the cam box or linkages will

produce erroneous guide position feedback. Although this mechanism discloses a master / follower

5   arrangement that is electronically controlled, the stroke of the traverse guide is reliant on the linkage.

Variable stroke adjustment is not addressed. In order to compensate for non-uniform motion of the

linkage, a cam box is employed. The filament guide is housed in a flat self-lubricating slide block. The

eventual wear of both the cam box and the slide block are not desirable. Another detrimental quality of

the sliding block traverse is the filament misalignment while winding. In any lateral traversing

10   mechanism the filament is exposed to angular displacement that accumulates product, causing

fluctuations in tension. These tension fluctuations have to be compensated for. The most common means

of compensation is a multiple pass accumulator. This introduces additional undesirable radial bends to the

filament.

        Prior traversing art utilizes numerous means to transform rotary motion to lateral motion. The

15   most common of these mechanisms is illustrated in Fig 8. The driving means as represented by (75) can

be either separately derived or common to the winding member (80). The reciprocating motion of the

filament guide (79) is accomplished by the rotation of a crank (78). This rotation may be either

continuous or oscillating. The changing angles ((A), (B)) between the crank (78), the linkage arm (77)

and the filament guide (79) produces a stroke, that if uncorrected, would form a non uniform layering of

20   the filament (F). This distortion is compensated for by introducing a device that compensates for these

disparities. Most of these devices include cam mechanisms (76). Prior art includes feedback devices to

communicate the position of the filament guide (74). Prior art has contained the filament guide by the use

of linear slides and pivotal mounts. These devices exhibit various difficulties that are detrimental to the

high speed processing of delicate products. The first of these is one of mass. As more components are

25   added to the device to compensate for non-uniform motion, the inertial load is increased, hindering the

speed or directional changes of the guide. If stroke adjustments are desired, the linkage must be adjusted

or changed or the rotation of the driving member reversed. The surface-to-surface frictional wear of both

the slides and cam devices add to the problematic characteristics. If position feedback (74) is employed at the driving means (75), the position of the guide is dependant on mechanical constants that change due to wear and maladjustment. The means by which the traverse guide is synchronized with the winding member is either direct drive or speed following. Ratio changes in direct driven devices are accomplished

5   through mechanical components that add to the mass of the device. Speed following devices are prone to accumulating error. The final drawback that is inherent to these devices is one of product misalignment. When traversing delicate product at high speeds it is essential to try to maintain an undisturbed alignment to the winding member. The oscillation of the guide creates angular deflection of this alignment (C), (D). This deflection causes two problems. The additional linear accumulation causes tension fluctuations. In

10   addition, the misalignment of the product to the guide creates a bend at the contact point (E).

SUMMARY OF THE INVENTION

Briefly stated, one aspect of the invention contemplates an improved guiding means by

15   which a continuous segment of the product is moved in a plane parallel to the axis of the spool or core of the winding device, while reducing the inertial load of the traversing mechanism and minimizing the angular deflection of the product, thereby increasing the speed by which the product can be traversed in a precise manner. A second aspect is the precise locating of the traverse guide, which is accomplished by employing a novel digital addressing strategy that

20   utilizes a digital feedback device that is located after the linkages that produce non-uniform motion of the guide. By implementing this method, compensating cams that are required to counteract mechanical deficiencies are eliminated. It is also the intention of the invention to reduce the self-destruction of the members by eliminating surface-to-surface wear due to friction. It is an object of the invention to electronically interface the motion of the traversing guide with

25   the winding member, so that the positioning of traverse motion may be programmed for required traverse profiles and reversals of the guide. Thus, it is possible to utilize less than the entire arcuate path of motion of the free end of the guide, where use of the entire path is not required,

whereby the same mechanism may be employed for winding spools or coils of varying axial length.

BRIEF DESCRIPTION OF THE DRAWINGS

5   Figure 1 is a perspective view showing the general process by which the product is layered onto

a rotating arbor or spool, and the relationship of the guiding mechanism to the rotating member.

Figure 2 is a view in elevation showing a traversing mechanism forming a part of the embodiment of

the invention.

Figure 2a is a side view in elevation thereof.

10   Figure 3 is a block diagram showing the components used to synchronize the traverse assembly to the

winding member.

Figure 4 is a schematic drawing showing longitudinal motion of the traverse assembly as a function

of O and radius.

Figure 5 is a program flow of a logic processor (LP) and operator interface.

15   Figure 6 and 7 are diagrams that show the program flow of a traverse motor controller (MC).

Figure 8 is a block diagram showing prior art traversing mechanisms.

Legend:

	C1	Accumulative counter for the winding member
20	Cp	Pulse Per Revolution (PPR) of the winding member
	Cr	The accumulated rotational count of the winding member expressed in revolutions.
	Cs	The total accumulated count of counter C1
	Da	The digital address of any linear position along the winding plane (P)
	Dir	Direction of the Traverse Motor
25	Dti	Desired traverse position along the winding plane (P) in inches
	Dts	Desired rotational traverse position in encoder steps
	Fsi	Front stop expressed in inches

Goto   Programming command to the motor control processor

Hs   Homing Switch

L   Traverse Lead expressed in inches

O   Traverse origin, an angular position of 90 degs, with reference to the winding plane.

5   Rsi   Rear stop expressed in inches

Rss   Rear stop position expressed in encoder steps

Run   Run signal

Te   Traverse encoder

Tp   Pulses per revolution of the traverse encoder

10   Tw   Traverse width expressed in inches

Equations used:

$Cr = Cs/Cp$ $Fsi = Rsi + Tw$

$Rss = (asin(Rsi/r)) \times (Tp/2\pi)$

$Da = (asin(Y/r)) \times (Tp/2\pi)$ $Fss = (asin(Fsi/r)) \times (Tp/2\pi)$ $Dts = (asin(Dti/r)) \times (Tp/2\pi)$

15    $Dti = Fsi - (L \times Cr)$ or $Dti = Rsi + (L \times Cr)$. $t = asin(Y/r)$

DETAILED DESCRIPTION OF THE DISCLOSED EMBODIMENT

Referring to Figure 1, there is illustrated a longitudinally mounted guide (1), an orificed free end of which moves in a plane parallel to a winding surface (2) following the speed of a winding apparatus (3)

20   to a set ratio to result in layering of the wound product.

If the ratio of the guide (1) to the winding apparatus (3) is changed, the space between the layering may be increased or decreased at will. If the reversal at the end of the longitudinal stroke is changed, the layer width (4) may be increased or decreased as required.

One problem that exists is in the movement of the guide (1). The mechanism required to move

25   the guide to and fro to the position required, and to perform quick reversals of the direction at the end of a stroke, is of high inertia. A secondary disadvantage of this configuration is, at high speed; the motion of the guide in its path, causes tension fluctuations in the product due to the deviation of the guide from its

aligned position. Additionally, the accurate positioning of the guide is complicated by the angular losses of the linkages that are common to traversing mechanisms.

Referring to Figure 2 and 2a, when the arm (8) and product guide (9) are attached at a pivot (7) and allowed to swing about this pivot in an arc (10) that is parallel to the winding plane (P), the inertia of

5   the assembly is significantly reduced. By driving the pivotally mounted guide from a driven rotating crank (5), the rotational reversal of the crank is used to limit the stroke of the product guide (9). The flexible product is fed through entry hole (12) around sheave (13) through product guide (9) to the winding member (14). The rotating crank (5) converts rotary motion to linear motion through arm (6). This causes the entire assembly to oscillate around pivot (7). Due to the product path through the axis of

10   the mechanism, tension fluctuations that are caused by the side-to-side motion of longitudinal traversing are greatly reduced. The product guide (9) is so constructed as to guide the product only in the desired parallel winding plane. As the product leaves the sheave (13), it is free to form a natural angle to the varying diameter of the core. This path eliminates the sharp bends that are detrimental to many filament products. The ultimate goal of the invention is to position the product guide (9) in the precise desired

15   location along the winding plane (P) with respect to the rotational position of the winding member (14). It is also the intention to accomplish this by disregarding any non-uniform motion that is generated by angular inconsistencies created by the members (5), (6) and (8).

Figure 3 schematically illustrates the disclosed embodiment. Winding shaft (15) is driven by either a constant or variable speed motor (16), which may be manually controlled by a separate speed

20   controller. Element (17) is a digital feedback encoder driven from shaft (15) which sends a digital count signal to a logic controller (18). Logic controller (18) contains the necessary logic for the synchronization of the two drives, and interface from the operator input. Component (19) is the traverse motor controller that commands the traverse motor (20) to the desired position for accurate positioning. The rotary position of the traverse is communicated to the motor controller (19) by encoder (22). This positioning is

25   accomplished by utilizing a motion controller and motor that incorporates the capabilities of both speed (velocity) and position control. It is not the intention of this disclosure to detail the process by which the controller accomplishes the positioning of the motor, as there are numerous devices existing, that are well

known by those experienced in the art of motion control. Operator interface is accomplished by means of a process control device (21) with the capabilities of setting selectively any of a plurality of ratio and position criteria.

Prior to the start of the winding cycle, a "homing" routine is initiated. This routine rotates the

5   traverse drive motor (20) in the clockwise rotation until switch (24) is activated. This switch is positioned to activate when the traverse arm (8) is at right angle to the winding axis. At this point, the origin of the traverse arm (O) is set.

Figure 4 illustrates that the primary objective of the invention to locate the product at a desired, precise, location along the winding plane (P) with reference to the accumulated rotation of winding shaft

10   (Cr). To accomplish this task the first value that is ascertained is (Cr). Digital feedback encoder (17) is driven from shaft (15), which sends a digital count signal to counter (C1). This counter is a component of the logic processor (LP fig 5) and is capable of storing the accumulated count that sums the rotation of the winding shaft (Cr) from the time of reset. The next value ascertained is the desired location along winding plane (P). The linear position along winding plane (P) is defined as a linear measurement from the origin

15   (O). Any position to the right of (O) is a positive value. Any position to the left of (O) is a negative value. The process begins by placing the product at position (Fsi). The desired linear position (Dti) is now found by subtracting the product of (L) x (Cr) from (Fsi). (L) Is the desired lead of the product across the winding plane (P) as the process advances. Once the product reaches the desired rear stop position (Rsi), the accumulated count of (Cr) is reset to zero and the guide motion is reversed by adding the product of

20   [(L) x (Cr)] to (Rsi). This process continues until the required length is achieved. Therefore (Dti) is the desired traverse position, expressed in inches, along the product on winding plane (P) at any time in the winding cycle. (Dti) is found by adding to (Rsi), or subtracting from (Fsi), the product of (L) x (Cr).

Dti=Fsi -(L x Cr)   or   Dti=Rsi + (L x Cr).

(Rsi) is the end of the desired backward motion expressed in inches, which is manually measured

25   from origin and entered into the operator interface ((21) fig 5). ((Rsi) is a negative quantity). (Tw) represents the total traverse width, expressed in inches, and is operator entered. (Fsi) is the end of the desired forward motion, expressed in inches. (Fsi) is the sum of (Rsi) and (Tw).

Fsi=Rsi + Tw

These linear values must now be converted to a digital position of the traverse arm that the processors can comprehend. This is achieved by applying polar coordinates to the guide position. To convert the three variables defined as linear positions, (Dti), (Fsi) and (Rsi), into a value that can be used by the processors, the desired angular position of the traverse arm (8) for each of these variables first must be found. Encoder (22) is a bi-directional device that is configured to add or subtract pulses dependent on the direction of its rotation. Counter clockwise rotation adds, clockwise rotation subtracts. By summing theses pulses the processor is made aware of the position of the arm at any point in the process. In order to calculate any of the angular values with reference to the linear position along plane (P), each of these values are substituted for Y in the following equation.

$t = asin\ (Y/r)$

In order to ascertain the digital address of the encoder for these angular values the equation

$Da = t \times Tp/2\pi$ is used

Where:

Da= Digital address of encoder (22) for any position along the plane (P) referenced from the origin (O).

Tp= Steps per revolution of encoder (22)

r = length of the traverse arm in inches

Y= any linear point on the (P) plane referenced from the origin (O)

2π= Radians for one revolution (360°)

Therefore: $Da = (asin(Y/r)) \times (Tp/2\pi)$

This equation assigns the digital encoder address for any linear position.

Example:

Let: Rsi=4 inches   Tw=8 inches r=10.75 Tp=1800

Then: $Fsi = Rsi + Tw$ ... Fsi=4

$Fss = (asin(Fsi/r)) \times (Tp/2\pi)$.....Fss= 109

$Rss = (asin(Rsi/r)) \times (Tp/2\pi)$....Rss=-109

Where:

(Fss)= Front stop in steps (digital address);

(Rss)= Rear stop in steps (digital address)

In order to create a symmetrical package and for operator ease, it is required that the beginning

5   layer start at point (Fsi) and end at (Rsi). As the process starts, the position of the traverse is at (Fsi). The

logic continuously commands the motor to a position that satisfies the equation Dti=Fsi-(L x Cr). To

convert the linear position of Dti to a digital value of encoder (22) the equation

$$Dts=(asin(Dti/r)) \times (Tp/2\pi) \text{ is employed.}$$

Example:

10   Let: Cs = 640   Cp = 480   L = .2

Then: Cr=Cs/Cp   Cr=1.33 (revs)

        Dti = 4-(.2 x 1.33)   Dti = 3.73

        Dts= (asin(3.73/10.75) x (1800/2π)   Dts=101.6

When the product reaches (Rss) the accumulative count of (C1) is set to zero, the rotation of the

15   traverse motor is reversed and the equation Dti=Rsi+(L xCr) is applied. This process continues,

alternating between the two calculated values, as subsequent layers of filament are wound.

The process of layer winding requires that when the product reaches the end of the traverse

stroke at either (Rsi) or (Fsi), lateral motion must cease for a partial rotation of the winding arbor. This is

accomplished by ignoring the count from encoder (17) for a predetermined period and will be explained

20   in detail hereinafter.

Simply stated this process calculates the desired position of the traverse and commands the

motor to go to this desired digital address.

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SEQUENCE OF OPERATION

Figure 5 shows the program flow of the logic processor LP. (30), (31), (32), (34) are the values entered by the operator through the operator interface (21). The values are utilized to determine the values of (L) (Lead), (Tw) (Traverse width), (Rsi) (Rear stop in Inches)and lead dwell. These values are stored in the processor's memory. Value (31) and (32) are also applied to math block (33) for calculating (Fsi).

Values (30) and (32) are also directed to the motor control data bus (47) for later control of the traverse motor positioning. (39) is a discrete input to start or stop the run sequence. The logic of the run trigger is well within the talents of one skilled in the winding art. Neither is it necessary to specify in detail the type of switches, encoders, etc. as this is also within the capabilities of one skilled in the art.

Internal Relay (R1) is a latching relay that changes either state by applying a single pulse to the latch or unlatch inputs (40). (17) Is an encoder that sends a digital signal from the winding arbor which is passed through internal relay contacts (R1) to either accumulative counters (C1) or (C2) (Acc). (C1) is an accumulating counter that stores the value of (Cs), which is conveyed to math block (37) that evaluates the value of (Cr).

The function of counter (C2) is to accumulate counts from the winding arbor in place of (C1) to allow for lead dwell at the end of each traverse stroke. The accumulated count of (C1) is reset to zero by the internal relay (R1) at the end of each traverse stroke. This latching of (R1) also redirects the count (17) from (C1) to (C2). When the encoder count is routed to (C2), it is not incrementing (C1). (Cs) now remains at zero until the count (17) is directed back to (C1) through the unlatching of (R1). The preset (Pre) value of (C2) is manually set in the operator interface and conveyed to (C2) by (34). When the accumulated value (ACC) of (C2) reaches the (Pre) value, the done bit (Dn) is set. (R1) is unlatched (40) and the Acc value of (C2) is reset to zero. This process, in effect, halts the traverse motion by negating (Cr) for a predetermined period.

The sequence of operation starts with block (43). On startup and at the end of each cycle a "homing routine" (43) is initiated in the processor and a discrete signal is sent to the motor control com data bus (47). The processor waits for a "homing complete" signal to be received from the data bus (47) before allowing the run sequence to engage. Once the "homing complete" signal is received, the run sequence (45) is activated by the operator, which starts the winding member motor (46).

During the cycle, math block (37) is constantly calculating the rotational count (Cr) of the winding arbor by dividing (Cs) by (Cp). The result, (Cr) is a varying value of the rotational count of the arbor. Math block (33) calculates the value of (Fsi) by subtracting (Rsi) from (Tw). The values of (Cr), (L), (Fsi) and (Rsi) are directed to the motor controller MC through the com bus (47)

5   The Motor controller logic can be seen by referring to Figures 6 and 7. Data from the processor is communicated to the MC by the communication data bus (47). Math blocks (52) and (53) convert the linear values (Fsi) and (Rsi) into the digital global variables (Fss) and (Rss) that are used in the positioning process. (55) is a discrete input from the home switch (24) signifying that the traverse arm is at the origin position.

10   The numeric position of the traverse arm is derived in summing block (56) that sums the count from encoder (22), which is attached to the pivot of the traverse arm. Encoder (22) sends digital pulses to the block (56). Clockwise "CW" rotation of the encoder decreases the value; counterclockwise "CCW" rotation increases the value. This position value (Pos) is a global variable that is directed to the positioning segment of the motion controller as well as being available for calculation in blocks (68) and

15   (72). The accumulative value of the position is reset to zero on homing (62).

When the LP initiates a "homing routine"(58), block (59) communicates a CW rotation to the motion controller setting the velocity (Vel1) required for the precise positioning of the traverse arm origin (O). When block (60) is evaluated as true (switch (55) closed) the motor is commanded to stop motion (61) and the position value (Pos) is set to zero (62). This establishes the origin (O) position of the

20   traverse. This origin places the traverse arm at a right angle to the winding plane. The processor then commands the motor "Goto" position Fss (63). The arm is now placed at the precise location of the front stop (Fss) and the homing routine is complete. Block (64) signifies that the "homing routine" is complete after motion has ceased, which is reported back to LP through (47).

Referring to Fig 7, (54) is the input from the LP defining the values of (Cr) and (L) for use in

25   math blocks (66) and (70). When the run command is received from the LP, block (65) sets the motor to the CW rotation (Dir). Math block (66) calculates (Dti) and (Dts). (Dts) is defined as a global variable, which can be referenced throughout the processor. Block (67) commands the controller to "Goto" the

numeric position of (Dts) at a velocity (Vel2). This speed is sufficient to increment the traverse motor to

its predetermined position at all winding speed ranges. As the winding arbor count (Cr) increases, (Dts) is

incrementally decreased from the front stop (Fsi) by the value of (L x Cr). This process continues until the

position of the arm reaches the numeric value of the (Rss).

5   When block (68) is evaluated as true ((Pos)= (Rss)):

        (R1) is latched resetting the value of (Cr) (73) to zero.

        Block (69) reverses the direction (Dir) of the motor.

        The value of (Dti) is recalculated in block (70), in doing so block (71) commands the controller

to "Goto" the numeric position of (Dts) at a velocity (Vel2). As (Cr) increases, (Dts) is incrementally

10   increased from the rear stop (Rsi) by the value of (L x Cr). This process continues until (Pos) is equal to

(Fss).

When block (72) is evaluated as true:

(R1) is once again latched resetting the value of (Cr) to zero.

        The processor loops back to block (65) starting the process over again. This loop continues until

15   the run sequence is interrupted by the LP.

        The motion control block (57) of the MC controls the direction, velocity and position of the

traverse motor (20). The control of this motor (20) is primarily that of position. This position is controlled

by means of comparing the traverse arm position feedback from (56) to the commanded "Goto" position

from blocks (63), (67) or (71) and accelerating the motor until the positions equate. The direction of the

20   motor rotation (Dir) is controlled by the commands from the logic blocks (59), (65) or (69). The velocity

of the motor is set by means of the values conveyed from blocks (63), (67) and (71). The process by

which the controller accomplishes the precise positioning of the motor is well known in the art.

        It is now apparent that the positioning of the product across the winding plane is accomplished

by commanding the traverse motor to "Goto" a desired linear position that ignores the non-uniform

25   motion created by linkage deviations. The continuous looping of the process evaluates the desired

position and commands the motor to "Goto" this position, in doing so, any prior errors are compensated

for and are not accumulative. It may appear that this incremental motion of the traverse would cause the

arm to pulse to its commanded position, but this stepping motion is dampened by acceleration / deceleration settings in the motion controller.

It may thus be seen that I have invented new and highly useful improvements in flexible product spooling devices in which many of the disadvantages of prior art constructions have been eliminated or substantially ameliorated. A principle advantage of the present invention is the ability to instantaneously sense the precise position of the traverse arm independently of the mechanical means which move the traverse arm, thus effectively eliminating the effect of wear on mechanical parts. By simplifying the construction of the traverse arm so that the product is fed as directly as possible, undesirable stresses on the product are significantly reduced.

A manually adjustable digital processor is employed which uses a homing routine for initiating a cycle of movement which simplifies initial location of the traverse arm and the control over each successive traverse of the arm to its final stop when the spooling has been completed. The invention may be installed into many existing spooling devices with minimal modification.

I wish it to be understood that I do not consider the invention to be limited to the precise details of structure shown and described in the specification, for obvious modifications will occur to those skilled in the art to which the invention pertains.

I claim: